C.I.

THE FATE OF YOUNG CHILDREN IN TUBERCULOUS HOUSEHOLDS.

PUBLIC HEALTH

DIVISION.

Report of the "Lancashire Group" of Tuberculosis Officers to the Research Committee of the Joint Tuberculosis Council.

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JOINT TUBERCULOSIS COUNCIL.

RESEARCH COMMITTEE.

Report of the " Lancashire Group " of
Tuberculosis Officers on

" THE FATE OF YOUNG CHILDREN IN TUBERCULOUS HOUSEHOLDS."

I. INTRODUCTION.

Terms of Reference.

In April, 1925, the Research Committee of the Joint Tuberculosis Council, in dealing with subjects suitable for research on a territorial basis, passed a resolution inviting the Lancashire Group of Tuberculosis Officers to undertake an enquiry into " The Fate of Young Children of Tuberculous Households," in the Geographical County of Lancaster. The Committee requested one of their members, Dr. G. Lissant Cox, Central Tuberculosis Officer of the Lancashire County Council, to act as " convener " of the Group.

Summary and Conclusions.

The summary and conclusions of this report are given on pages 37, 38 and 39.

Collection of Material.

The resolution of the Research Committee of the Council was conveyed by the convener to the chief tuberculosis officer of each of the seventeen county boroughs in Lancashire and to the consultant tuberculosis officers of each of the five dispensary areas and the two sub-areas in the Administrative County of Lancaster. The average population for 1921–26 of the county boroughs was 3,246,640, and of the Administrative County 1,774,663, making a total of 5,021,303 for the Geographical County. These tuberculosis officers were invited to assist in the research by furnishing histories of children in their areas who had been exposed to the risk of infection by living in a household where lived an adult person suffering from tuberculosis (pulmonary or non-pulmonary), and to prepare a scheme for carrying out the research.

NOTES ON RESEARCH WORK

CONCERNING

"FATE OF YOUNG CHILDREN IN TUBERCULOUS HOUSEHOLDS."

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1. "Tuberculous household" has been taken to mean a dwelling where a family (or may be two families) lives, and in which there is, or has been during the past five years an adult person (15 years of age or over) suffering from tuberculosis (pulmonary, non-pulmonary or "combined"). Thus, it would be in order to include a household where the mother died from tuberculosis late in 1920, or any year subsequent, and the family are still being visited, even if none of the children are infected.

2. The draft form to be filled in for each household has been made comprehensive so as to allow of classification from several different angles.

3. It is the intention to have all the forms classified and summarised at this office so as to secure uniformity.

4. Although the investigation is to deal with "young children," that is, children not over five years of age, provision is made in the form for particulars to be inserted of every child in the family not over 15 years of age, so that the history of the family can be "worked back" and a greater "young child" population secured, on which to make calculations.

5. Provision has been made in the form to show not only the healthy and tuberculous children, but also those afflicted with some complaint other than tuberculosis.

6. It is recognised that much of the information required for the form will have to be obtained from the parents themselves without any official means of verification. If dates, ages, and causes of death cannot be given accurately, approximate information will suffice.

G. LISSANT COX,
Central Tuberculosis Officer,
Lancashire County Council.

County Offices, Preston,
January, 1926.

II. ANALYSIS OF MATERIAL.

Young Children.

"Young Children" has been interpreted to mean boys and girls up to the age of five years.

The children dealt with in this research have been confined to those born after the war, namely in 1919 to 1926. The actual years of birth are distributed as follows for the three groups into which the children have been divided :

Year.	Number of Children Observed in Tuberculous Households.		
	Households with adult positive sputum case.	Households with adult case with negative or absent sputum.	Households with adult case with non-pul. tuberculosis.
1919	77	21	2
1920	127	52	5
1921	125	41	3
1922	156	65	6
1923	143	75	5
1924	178	61	4
1925	155	77	7
1926	62	36	3
Total	1,023	428	35

The Adult "Infective" Case.

In every instance of the cases analysed, the "infective" adult in the household has had tuberculosis definitely diagnosed by the tuberculosis officer and entered on his clinical records before the birth of the child whose life has been observed.

The adult cases, by contact with whom the children in the same household have been exposed to risk, have been divided into the following groups :

Group 1. Pulmonary Tuberculosis, with positive sputum.

N.B.—The sputum has been demonstrated as positive sometime during treatment ; about ninety per cent. had a positive sputum before the birth of the child. The positive sputum cases were in early, intermediate or advanced stages of the disease.

Group 2. Pulmonary Tuberculosis, with negative or absent sputum.

N.B.—In this group are included all cases of pulmonary tuberculosis in which the sputum has never been demonstrated as positive.

Group 3. Non-Pulmonary Tuberculosis.

Each of these three groups has further been divided into the following sections according to the relationship of the adult tuberculous case to the child :

(*a*) Tuberculous mother.
(*b*) Tuberculous father.
(*c*) Other tuberculous relative.

N.B.—" Relative," includes uncle, aunt, grandfather, grandmother, adult brother, adult sister.

(*d*) Tuberculous lodger.

N.B.—Includes any adult tuberculous person in the household who is of no relation to the child.

In this enquiry the age of the adult tuberculous case in the household has not been taken into consideration when classifying the results.

In five households both the mother and father suffered from pulmonary tuberculosis with sputum positive ; the cases could not properly be classified under (*a*) tuberculous mother, or (*b*) tuberculous father, and being insufficient for a separate group they were excluded from the main tables. There were five children concerned—one in each household—and their after-history showed : 1 died from a cause other than tuberculosis before attaining twelve months ; 1 died from pulmonary tuberculosis between two and three years of age ; 1 alive at age five but suffering from tuberculosis ; and 2 were alive and healthy at age five.

Similarly, there were five households where both parents suffered from pulmonary tuberculosis with negative sputum, and the cases

have been excluded from the tables. The after-history of the 5 children concerned showed: 1 died from a cause other than tuberculosis before attaining twelve months; the remaining 4 were alive and healthy when observed at age two (2), four and five years.

In a number of instances, in addition to the tuberculous parent, there was also another tuberculous case in the household. Children in such households have been classified under the nearest relative—(*a*) or (*b*) or (*c*)—with a positive sputum, or, if no adult positive sputum case, then the nearest relative.

Population "at risk."

The following statement shows for each of the three groups into which the tuberculous households have been divided, the number of children exposed to risk, and the relationship to the adult case:—

Group 1. Infective Cases with Positive Sputum.

	No. of Tub. Households.	No. of Children exposed to risk.
(*a*) Tuberculous Mother	221	244
(*b*) Tuberculous Father	428	588
(*c*) Other Tuberculous Relative ...	128	173
(*d*) Tuberculous Lodger	8	18
TOTAL	785	1023

Group 2. Adult Cases with Negative or No Sputum.

(*a*) Tuberculous Mother	76	121
(*b*) Tuberculous Father	162	276
(*c*) Other Tuberculous Relative ...	17	28
(*d*) Tuberculous Lodger	2	3
TOTAL	257	428

Group 3. Adult Cases with Non-Pulmonary Tuberculosis.

(*a*) Tuberculous Mother	4	7
(*b*) Tuberculous Father	13	19
(*c*) Other Tuberculous Relative ...	4	9
(*d*) Tuberculous Lodger	—	—
TOTAL	21	35
TOTAL, *Groups* 1, 2 *and* 3 ...	1063	1486

The relatively small number of children of tuberculous mothers compared with the children of tuberculous fathers needs some explanation, because no selection was made by the various tuberculosis officers. The chief reason is that pulmonary tuberculosis is more prevalent in Lancashire among young women than young men (ages 15—35). Further, tuberculous women, by contracting the disease before or about marriageable age, are less likely to marry than tuberculous men, who mainly contract the disease at a later age in life after they have married.

The majority of the children have remained in the households throughout their period of observation for this research; a small number, however, may have been sent by the parents to the homes of relatives for varying short periods, but not to any extent to affect the results of this research. A further factor to be considered is that in a number of instances the adult tuberculous case in the household will have received treatment for two months or more in a sanatorium or hospital, thus reducing slightly the duration of the child's exposure to possible infection. Substantially, however, the children dealt with in this research have been in constant contact with an adult tuberculous case in their homes.

History of Children "exposed to risk."

The children exposed to risk have been classified so as to show their position (e.g. living, or died from pulmonary tuberculosis, non-pulmonary tuberculosis, causes other than tuberculosis, and all causes), when in the age-groups 0—1 years, 1—2 years, 2—5 years. In this research, therefore, a child born in, say 1920, and living to five years of age or over, is included as living in age-group 0—1, living in group 1—2, and again living in group 2—5.

Expressed in another way, the population of children "exposed to risk" in age-groups 0—1, 1—2 and 2—5 has been ascertained during the years 1919—1926, and consequently on basing the results on past periods, some children may be included in the two earlier age-groups and some in all three age-groups.

The death-rates from (i) pulmonary tuberculosis, (ii) non-pulmonary tuberculosis, (iii) causes other than tuberculosis, and (iv) all causes, among the children "exposed to risk" have been calculated for each of the age-groups 0—1, 1—2, and 2—5 per 1,000 of the total children in each age group. At the suggestion of the late Dr. J. Logan Stewart, two tables—Nos. 6 and 12—have been inserted, showing the causes of death in addition to tuberculosis.

The " probable error " has been calculated on the formula :—

$$\text{Death-rate per 1,000 plus or minus } \frac{\cdot 6745}{N}\sqrt{\frac{m\,n}{N}} \times 1{,}000$$

N = Total population in group.
n = No. of deaths in group.
m = Population minus deaths.

This is the formula given by Sir Arthur Newsholme in *Elements of Vital Statistics*, (p. 510).

The object of this formula is to provide some measure of the fluctuations from an ideal, or most probable, value likely to arise by mere luck. For instance, if in an observed group a death-rate exceeding (or falling short of) the expected death-rate by twice the probable error were found, this is a result which by mere luck of small numbers might be expected to occur about nine times in every hundred trials. If the difference were three times the probable error, one would expect it to occur about twenty-two times in every thousand trials. So, one tends to say that if a deviation so unlikely as this to occur does actually occur, then it is more likely that no chance, but some *significant* difference in the circumstances, is responsible. What should be taken as the limit is clearly a matter of personal opinion : here I have taken the rather lenient criterion of twice the probable error.

Inheritance.

It may naturally be argued that in this research the question of inheritance enters. The factor of inheritance cannot be estimated, as no dividing line can be drawn between (1) the predisposition of a child to the disease through having a tuberculous parent, and (2) the influence on a child of being in a tuberculous household.

III. THE " CONTROL " POPULATION.

For the purpose of affording comparison with the experience of the ordinary population, the Geographical County of Lancaster has been taken as the " control," as it corresponds nearly with the area in which the research has been made. In group 1 (that is, children in households with adult positive sputum infective case) the forms, however, supplied by the tuberculosis officers of County Boroughs and used in this research have been far fewer in proportion to the Borough

total population (464 children and 3,246,640 population) than those supplied by the tuberculosis officers of the Administrative County (559 children and 1,774,663 population). The death-rates from tuberculosis and other diseases are less in the Administrative County than in the aggregate of the County Boroughs. This may be taken as an inevitable weakness in "collective research."

As there is this higher mortality on the average in the County Boroughs, an adjustment is necessary.

For instance, in the Geographical County, the death-rate in the age-group 0 to 1 was 105·0—County Boroughs 110·9 and Administrative County 92·6; difference 18·3. In this age-group the proportion of population in the Geographical County resident in the County Boroughs was 68·2 per cent., whereas in the observed population the proportion was 45·3 per cent. I have therefore reduced the excess death-rate of 18·3 of the County Boroughs by the fraction $\frac{45{\cdot}3}{68{\cdot}2}=12{\cdot}15$, and subtracted the balance of the excess 6·15, (18·3—12·15 = 6·15), from the Geographical County death rate of 105·04 = 98·89.

For groups 2 and 3, it has not been necessary to make any adjustment in the "control" death-rates, because the County area forms did not predominate.

From the Registrar-General's Statistical Returns have been extracted the actual deaths of children in Lancashire from pulmonary tuberculosis, non-pulmonary tuberculosis, causes other than tuberculosis and all causes, in age groups 0—1, 1—2 and 2—5 years during the six years 1921 to 1926. The population of Lancashire in these age-groups has been estimated and averaged for the six years, and on them the death-rates calculated per 1,000 of the particular group reviewed, as is usual in vital statistics.

The "control" period 1921—1926 does not entirely coincide with the period 1919—1926 in which the fate of young children of tuberculous households has been observed, but it has been taken from 1921 to avoid the rather abnormal number of births after the war in 1919 and 1920, and the difficulty in estimating nearly enough the population in those years. On the other hand, the children exposed

to risk in tuberculous households in 1919 and 1920 have been included, in order to base the report on as large a number of children as possible.

IV. RESULTS.

Group 1.—*Children in tuberculous households in which the adult infective case suffered from* Pulmonary Tuberculosis with Positive Sputum.

The following tables 1 to 4, give separate figures for : (*a*) tuberculous mothers, (*b*) tuberculous fathers, (*c*) other relatives, and (*d*) tuberculous lodgers :—

GROUP 1. TABLE 1.

Children born of tuberculous mothers suffering from pulmonary tuberculosis with positive sputum.

Age-Group. Years.	CHILDREN EXPOSED TO RISK. Total Number Observed.			D = Actual Number of Deaths. D-r. = Death-Rate per 1,000. P.e. = Probable Error ±	Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.			CONTROL: GEOGRAPHICAL COUNTY OF LANCASTER. Estimated Population Average 1921–1926.			Death-rate (adjusted*) per 1,000 of Population—Average 1921–1926. Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.		
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M & F	M	F	M	F	M	F	M	F	M&F
0—1	120	124	244	D.	—	1	3	4	7	13	10	18	28	44,012	43,599	87,611	0·2	—	1·8	1·2	111·0	82·7	113·1	84·0	98·8
				D-r.	—	8·1	25·0	32·2	58·3	104·8	83·3	145·2	114·7												
				P.e.	—	*5·4*	*9·6*	*10·7*	*14·4*	*18·5*	*17·0*	*21·3*	*13·7*												
1—2	95	95	190	D.	—	—	3	—	2	3	5	3	8	42,479	42,233	84,712	0·4	0·3	2·1	1·5	31·3	28·5	33·9	30·3	32·1
				D-r.	—	—	31·6	—	21·0	31·6	52·6	31·6	42·1												
				P.e.	—	—	*12·1*	—	*9·7*	*12·1*	*15·4*	*12·1*	*9·8*												
2—5	52	52	104	D.	—	1	1	1	2	2	3	4	7	122,114	120,734	242,848	0·2	0·1	0·8	0·7	7·5	6·9	8·6	7·8	8·2
				D-r.	—	19·1	19·1	19·1	38·2	38·2	57·3	76·5	66·9												
				P.e.	—	*12·7*	*12·7*	*12·7*	*17·9*	*17·9*	*21·8*	*24·9*	*16·5*												

* Adjusted death rates—see explanatory note on page 9.

Group 1. TABLE 2.

Children born of tuberculous fathers suffering from pulmonary tuberculosis with positive sputum.

Age-Group. Years.	Children Exposed to Risk. Total Number Observed.			D = Actual Number of Deaths. D-r. = Death-Rate per 1,000. P.e. = Probable Error ±									CONTROL: Geographical County of Lancaster. Estimated Population Average 1921–1926.			Death-rate (adjusted*) per 1,000 of Population—Average 1921–1926.								
					Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.						Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.		
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M&F	M	F	M	F	M	F	M	F	M&F
0—1	289	299	588	D.	—	2	1	5	26	13	27	20	47	44,012	43,599	87,611	0·2	0·2	1·8	1·2	111·0	82·7	113·1	84·0	98·8
				D-r.	—	6·7	3·5	16·7	89·9	43·5	93·4	66·9	79·9												
				P.e.	—	*3·1*	*2·3*	*5·0*	*11·3*	*7·9*	*11·5*	*9·7*	*7·5*												
1—2	248	266	514	D.	—	—	5	9	3	6	8	15	23	42,479	42,233	84,712	0·4	0·3	2·1	1·5	31·3	28·5	33·9	30·3	32·1
				D-r.	—	—	20·2	33·8	12·1	22·5	32·2	56·4	44·7												
				P.e.	—	—	*6·0*	*7·3*	*4·6*	*6·1*	*7·5*	*9·5*	*6·1*												
2—5	147	164	312	D.	—	—	3	—	7	1	10	1	11	122,114	120,734	242,848	0·2	0·1	0·8	0·7	7·5	6·9	8·6	7·8	8·2
				D-r.	—	—	20·3	—	47·4	6·1	67·7	6·1	35·2												
				P.e.	—	—	*7·8*	—	*11·5*	*4·1*	*14·0*	*4·1*	*7·0*												

* Adjusted death rates—see explanatory note on page 9.

GROUP 1. TABLE 3.

Children born in same household as tuberculous relatives suffering from pulmonary tuberculosis with positive sputum.

Age-Group. Years.	CHILDREN EXPOSED TO RISK.													CONTROL: GEOGRAPHICAL COUNTY OF LANCASTER.										
	Total Number Observed.			D = Actual Number of Deaths. D-r. = Death-Rate per 1,000. P.e. = Probable Error ±										Estimated Population Average 1921–1926.			Death-rate (adjusted*) per 1,000 of Population—Average 1921–1926.								
					Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.						Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.		
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M & F	M	F	M	F	M	F	M	F	M&F
0—1	77	96	173	D.	—	—	1	1	5	3	6	4	10	44,012	43,599	87,611	0·2	0·2	1·8	1·2	111·0	82·7	113·1	84·0	98·8
				D-r.	—	—	12·9	10·4	64·9	31·2	77·9	41·7	57·8												
				P.e.	—	—	*8·7*	*6·9*	*18·9*	*11·9*	*20·6*	*13·7*	*11·9*												
1—2	69	86	155	D.	—	1	3	1	2	2	5	4	9	42,479	42,233	84,712	0·4	0·3	2·1	1·5	31·3	28·5	33·9	30·3	32·1
				D-r.	—	11·6	43·5	11·6	28·9	23·2	72·5	46·4	58·0												
				P.e.	—	*7·7*	*16·5*	*7·7*	*13·6*	*10·9*	*21·0*	*15·3*	*12·6*												
2—5	28	49	77	D.	—	—	1	1	—	2	1	3	4	122,114	120,734	242,848	0·2	0·1	0·8	0·7	7·5	6·9	8·6	7·8	8·2
				D-r.	—	—	35·3	20·3	—	40·6	35·3	60·8	51·5												
				P.e.	—	—	*23·6*	*13·6*	—	*19·0*	*23·6*	*23·1*	*17·0*												

* Adjusted death rates—see explanatory note on page 9.

Group 1. TABLE 4.

Children born in same household as tuberculous lodger suffering from pulmonary tuberculosis with positive sputum.

Age-Group. Years.	Children Exposed to Risk.													CONTROL: Geographical County of Lancaster.										
	Total Number Observed.			D = Actual Number of Deaths.										Estimated Population Average 1921–1926.			Death-rate (adjusted*) per 1,000 of Population—Average 1921–1926.								
					Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.						Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.		
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M & F	M	F	M	F	M	F	M	F	M&F
0—1	9	9	18	D.	—	—	—	—	—	—	—	—	—	44,012	43,599	87,611	0·2	0·2	1·8	1·2	110·0	82·7	113·1	84·0	98·8
1—2	9	8	17	D.	—	—	—	1	1	—	1	1	2	42,479	42,233	84,712	0·4	0·3	2·1	1·5	31·3	28·5	33·9	30·3	32·1
2—5	4	3	7	D.	—	—	1	—	—	—	1	—	1	122,114	120,734	242,848	0·2	0·1	0·8	0·7	7·5	6·9	8·6	7·8	8·2

* Adjusted death rates—see explanatory note on page 9.

N.B.—The deaths of children exposed to risk are too small upon which to calculate death-rates.

Group 1. TABLE 5.

Summary of Tables 1—4.

In the following table 5 the previous tables 1 to 4 are further re-grouped to show the total children observed in each age-group irrespective of the relationship of the infective positive sputum case :—

Children Exposed to Risk.											Control.		
Total Number Observed.			D. = Actual Number of Deaths. D-r. = Death-rate per 1,000. P.e. = Probable Error. M.v. = Maximum variation (= twice P.e.)								Lancashire—Geographical County—Death-Rate (adjusted) per 1,000 of Population Average 1921–1926.		
			Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.				
M	F		M	F	M	F	M	F	M	F		M	F
(i) Age-Group 0—1 Years.													
495	528	D.	—	3	5	10	38	29	43	42	Pulm. Tub.	0·2	0·2
		D-r.	—	5·7	10·1	18·9	76·8	54·9	86·9	79·5	Non-Pulm. Tub.	1·8	1·2
1023		P.e.	—	2·2	3·0	4·0	8·1	6·6	8·5	7·9	Other Causes	111·1	82·7
			M & F		M & F		M & F		M & F		All Causes	113·1	84·0
												M & F	
		D.	3		15		67		85				
		D-r.	2·9		14·7		65·5		83·1		D-r. All Causes	.. 98·8	
		M.v.	*2·3*		*5·1*		*10·4*		*11·6*				
(ii) Age-Group 1—2 Years.													
421	455	D.	—	1	11	11	8	11	19	23	Pulm. Tub.	0·4	0·3
		D-r.	—	2·4	26·1	24·2	19·0	24·2	45·1	50·5	Non-Pulm. Tub.	2·1	1·5
876		P.e.	—	1·4	5·2	4·8	4·4	4·8	6·8	6·9	Other Causes	31·3	28·5
			M & F		M & F		M & F		M & F		All Causes	33·9	30·3
												M & F	
		D.	1		22		19		42				
		D-r.	1·1		25·1		21·7		47·9		D-r. All Causes	.. 32·1	
		M.v.	*1·1*		*7·1*		*6·6*		*9·6*				
(iii) Age-Group 2—5 Years.													
232	269	D.	—	1	6	2	9	5	15	8	Pulm. Tub.	0·2	0·1
		D-r.	—	3·7	25·8	7·4	38·7	18·6	64·6	29·7	Non-Pulm. Tub.	0·8	0·7
501		P.e.	—	2·5	7·0	3·5	8·5	5·5	10·8	6·9	Other Causes	7·5	6·9
			M & F		M & F		M & F		M & F		All Causes	8·6	7·8
												M & F	
		D.	1		8		14		23				
		D-r.	1·9		15·9		27·9		45·9		D-r. All Causes	.. 8·2	
		M.v.	*1·9*		*7·5*		*9·9*		*12·6*				

Probable Error (P.e.)—This is an arithmetical calculation based upon a definite formula to make allowance for the possibility of chance operating in selecting a group of cases. (See formula on page 8).

Maximum Variation (M-v.)—This has been taken as twice the probable error.

Example : Table 5 above, age-group 0—1 years ; death rate from ALL CAUSES 83·1, maximum variation 11·6. Add this to 83·1 equals 94·7. The control death-rate was 98·6. The death-rate of 83·1 plus 11·6 is still less than the control of 98·6. Therefore it is regarded significant.

Group 1. TABLE 6.

Analysis of Causes of Death.

The table below shows the causes of death among the children born in the same household as tuberculous parents, other relatives and lodgers suffering from pulmonary tuberculosis with positive sputum, and contrasts the proportion of deaths from particular causes with the corresponding figures for England and Wales.

Cause of Death.	Children Exposed to Risk.										**Control :** England and Wales.† Percentage to Total Deaths Ages 0—5. (Average for 6 years 1921–26).
	Age and Sex of Children who died from the subjoined diseases.									Percentage to Total Deaths Ages 0—5.	
	0—1		1—2		2—5		Total, 0–5.				
	M	F	M	F	M	F	M	F	M&F		
Tuberculosis of the Respiratory System ...	—	3	—	1	—	1	—	5	**5**	**3·3**	**0·6**
Other Forms of Tuberculosis :											
(a) Bones and Joints ...	—	—	—	—	1	—	1	—	**1**		
(b) Abdomen	1	—	2	1	—	—	3	1	**4**		
(c) Tub. Meningitis ...	3	9	7	7	3	2	13	18	**31**	**30·0**	**3·8**
(d) General Tuberculosis ...	1	—	2	3	2	—	5	3	**8**		
(e) Peripheral Glands ...	—	1	—	—	—	—	—	1	**1**		
Measles	—	1	—	—	1	—	1	1	**2**		
Scarlet Fever	—	—	—	—	—	—	—	—	—		
Whooping Cough	1	1	1	—	—	—	2	1	**3**	**4·0**	**13·1**
Diphtheria	—	—	—	1	—	—	—	1	**1**		
Influenza	1	—	—	—	—	—	1	—	**1**	**0·7**	**1·5**
Meningitis—Not Tuberculous	2	4	1	1	1	—	4	5	**9**	**6·0**	**1·6**
Bronchitis	1	1	1	1	—	—	2	2	**4**		
Pneumonia—All Forms ...	4	6	3	4	4	2	11	12	**23**	**18·0**	**25·7**
Other Respiratory Diseases ...	—	—	—	—	—	—	—	—	—		
Congenital Debility, congenital malformation, premature birth, etc.	16	4	1	2	—	—	17	6	**23**	**15·3**	**27·7**
Convulsions	6	3	—	—	1	1	7	4	**11**	**7·3**	**4·5**
Miscellaneous :											
Heart Disease	1	3	—	—	—	—	1	3	**4**		
Diarrhœa, &c.	1	—	—	—	—	—	1	—	**1**		
Encephalitis Lethargica ...	—	—	—	—	—	—	—	—	—		
Infantile Paralysis	—	1	—	—	—	—	—	1	**1**	**15·3**	**21·5**
Accident	—	1	—	—	2	—	2	1	**3**		
Cause not Known	5	4	1	2	—	2	6	8	**14**		
TOTAL DEATHS	43	42	19	23	15	8	77	73	**150**	**100·0%**	**100·0%**
Number of CHILDREN OBSERVED in each age-group	495	528	421	455	232	269	* 495	* 528	* **1023**	—	—

* These are the total number of individual children observed between birth and 5 years of age (see page 8, third paragraph).

† The control relates to England and Wales because the figures for the Geographical County of Lancaster were not readily available.

Group 1. TABLE 7.

Environment.

In order to measure, in some degree, the effect of home conditions on the fate of young children, the tuberculous households in which the infective adult had a positive sputum have been divided into two groups according to the classification by the tuberculosis officer or health visitor of the home conditions as (*a*) *good* and (*b*) *bad* (the intermediate classifications of "fair," "moderate," etc. being ignored). The following statement shows the result :

Fate of Young Children (0—1 years) in Tuberculous (positive sputum) Households which have been classified as (a) *good and* (b) *bad.*

Classification of Households	Number of Households.	Number of Children Exposed to Risk.	D. = Deaths. D-r. = Death-rates per 1,000 of children during first year of life. P.e. = Probable error ±				
				Pulm. Tuberc.	Non-Pul. Tuberc.	Other Causes	All Causes.
(a) *Good*	356	482	D.	—	7	27	34
			D-r.	—	14·5	56·0	70·5
			P.e.				*7·8**
(b) *Bad*	303	466	D.	3	5	35	43
			D-r.	6·4	10·7	75·1	92·2
			P.e.				*9·0**

* Probable error of difference, 8·07.

After eliminating the factor of chance (provided by the probable error of difference), the comparison between the death-rate from *all causes* in the good and bad homes is barely "significant." The two death-rates—70·5 in the good households compared with 92·2 per 1,000 in the bad households—is not nearly so great as might perhaps be expected.

It is clear that the figures relating to deaths from *tuberculosis only* are too small upon which to base conclusions.

Conclusions from Tables 1—7.

(*Group 1.—Adult positive sputum infective cases.*)

1. The deaths from *Pulmonary Tuberculosis* of children exposed to risk in tuberculous households are too small upon which to base any conclusions.

2. The death-rate from *Non-Pulmonary Tuberculosis* of children exposed to risk in tuberculous households (see table 5) was greatly in excess of the rate from the same cause among children in the Geographical County of Lancaster, serving as the " control "—the rate being :

Nine times greater in the age group 0—1 ;

Fourteen times greater in the age group 1—2 ;

Nineteen times greater in the age group 2—5.

3. The mortality rate from *Non-Pulmonary Tuberculosis* among the children exposed to risk was greater in those exposed to infection from a tuberculous mother than a tuberculous father.

4. Among the children aged 0—5 exposed to risk, two-thirds of the deaths from *Non-Pulmonary Tuberculosis* were due to Tuberculous *Meningitis*. (See table 6.)

5. The death-rate from *Causes other than Tuberculosis :*

(*a*) Among the 1,023 children exposed to risk in age group 0—1 was less than in the " control " population, being 65·5 per 1,000 compared with 98·6—a significant difference.

(*b*) Among 876 children in age group 1—2, the disparity persisted, but to a less degree—21·7 per 1,000 compared with 32·1—a significant difference.

(*c*) In the age group 2—5, 501 children, the rate for children in tuberculous households was, however, greater than in the " control " population, 27·9 compared with 8·2—a significant difference.

6. The death-rate from *All Causes* among the 1,023 children exposed to risk :

(*a*) in age group 0—1 was lower than the " control " population —83·1 against 98·8—a significant difference.

(*b*) In the second age group, 1—2, 876 children, the positions changed, the " control " death-rate being 32·1, and the children in tuberculous households 47·9—a significant difference.

(*c*) In the 2—5 age group, the difference became more pronounced, the " control " being 8·2, and the children in tuberculous households 45·9—a significant difference.

7. Adding the several deaths from pulmonary tuberculosis to the more numerous deaths from non-pulmonary tuberculosis, we find that 1·7 per cent. of children exposed to risk in tuberculous households died from *tuberculosis* in age group 0—1 ; 2·6 per cent. in group 1—2 ; and 1·8 per cent. in group 2—5. The deaths from pulmonary and non-pulmonary tuberculosis in the corresponding age groups of the " control " population were : 0·2, 0·2 and 0·1 per cent. These differences are significant.

8. As regards males and females, it is remarkable that the female babies (twelve months and under) of tuberculous positive sputum mothers succumbed from All Causes at a much greater rate than the boys.

GROUP 2.—*Children in tuberculous households in which the adult case suffered from* PULMONARY TUBERCULOSIS WITH NEGATIVE OR NO SPUTUM.

Following are Tables 8, 9 10, 11 and 12, dealing with Group 2, namely, children in tuberculous households in which the adult case suffered from pulmonary tuberculosis with negative or no sputum.

The following Tables 8, 9 and 10 give separate figures for : (*a*) tuberculous mothers, (*b*) tuberculous fathers, and (*c*) other relatives.

Group 2. TABLE 8.

Children born of tuberculous mothers suffering from pulmonary tuberculosis with negative or no sputum.

Age-Group. Years.	Children Exposed to Risk. Total Number Observed.			D = Actual Number of Deaths. D-r. = Death-Rate per 1,000. P.e. = Probable Error.									CONTROL: Geographical County of Lancaster. Estimated Population Average 1921–1926.			Death-rate per 1,000 of Population—Average 1921–1926.								
					Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.						Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.		
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M&F	M	F	M	F	M	F	M	F	M&F
0—1	59	62	121	D.	—	—	1	—	2	2	3	2	5	44,012	43,599	87,611	0·2	0·2	1·9	1·3	118·3	88·0	120·4	89·5	105·0
				D-r.	—	—	16·9	—	33·9	32·5	50·8	32·2	41·3												
				P.e.	—	—	*11·1*	—	*15·9*	*15·1*	*19·3*	*15·1*	*12·2*												
1—2	48	52	100	D.	—	—	—	—	—	2	—	2	2	42,479	42,233	84,712	0·5	0·3	2·2	1·6	33·4	30·4	36·1	32·3	34·2
				D-r.	—	—	—	—	—	38·5	—	38·5	20·0												
				P.e.	—	—	—	—	—	*17·9*	—	*17·9*	*9·4*												
2—5	26	29	55	D.	—	—	—	—	—	—	—	—	—	122,114	120,734	242,848	0·2	0·1	0·9	0·8	8·0	7·4	9·1	8·3	8·7
				D-r.	—	—	—	—	—	—	—	—	—												
				P.e.	—	—	—	—	—	—	—	—	—												

Group 2. TABLE 9.

Children born of tuberculous fathers suffering from pulmonary tuberculosis with negative or no sputum.

Age-Group. Years.	Children Exposed to Risk.													CONTROL: Geographical County of Lancaster.										
	Total Number Observed.			D = Actual Number of Deaths. D-r. = Death-Rate per 1,000. P.e. = Probable Error.										Estimated Population Average 1921–1926.			Death-rate per 1,000 of Population— Average 1921–1926.								
					Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.						Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.		
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M & F	M	F	M	F	M	F	M	F	M&F
0—1	125	151	276	D.	—	1	1	—	5	10	6	11	17	44,012	43,599	87,611									
				D-r.	—	6·6	8·0	—	40·0	66·2	48·0	72·8	61·6				0·2	0·2	1·9	1·3	118·3	88·0	120·4	89·5	105·0
				P.e.	—	*4·5*	*5·4*	—	*11·8*	*13·6*	*12·9*	*14·3*	*9·7*												
1—2	113	127	240	D.	—	—	1	1	2	3	3	4	7	42,479	42,233	84,712									
				D-r.	—	—	8·8	7·9	17·7	23·6	26·5	31·5	29·2				0·5	0·3	2·2	1·6	33·4	30·4	36·1	32·3	34·2
				P.e.	—	—	*5·9*	*5·2*	*8·4*	*9·1*	*10·2*	*10·4*	*7·3*												
2—5	70	71	141	D.	—	—	1	1	3	1	4	2	6	122,114	120,734	242,848									
				D-r.	—	—	14·3	14·1	42·8	14·1	57·1	28·2	42·6				0·2	0·1	0·9	0·8	8·0	7·4	9·1	8·3	8·7
				P.e.	—	—	*9·6*	*9·4*	*16·3*	*9·4*	*18·7*	*13·2*	*11·5*												

Group 2. TABLE 10.

Children born in same household as tuberculous relatives suffering from pulmonary tuberculosis with negative or no sputum.

Age-Group. Years.	Children Exposed to Risk.													Control: Geographical County of Lancaster.										
	Total Number Observed.				D = Actual Number of Deaths.									Estimated Population Average 1921–1926.			Death-rate per 1,000 of Population—Average 1921–1926.							
					Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.						Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.	
	M	F	M&F		M	F	M	F	M	F	M	F	M&F	M	F	M & F	M	F	M	F	M	F	M	F	M&F
0—1	9	19	28	D.	—	—	—	—	1	1	1	1	2	44,012	43,599	87,611	0·2	0·2	1·9	1·3	118·3	88·0	120·4	89·5	105·0
1—2	7	18	25	D.	—	—	1	—	—	1	1	1	2	42,479	42,233	84,712	0·5	0·3	2·2	1·6	33·4	30·4	36·1	32·3	34·2
2—5	1	12	13	D.	—	—	—	—	—	—	—	—	—	122,114	120,734	242,848	0·2	0·1	0·9	0·8	8·0	7·4	9·1	8·3	8·7

N.B.—The deaths of children exposed to risk are too small upon which to calculate death-rates.

Group 2. TABLE 11.

Summary of Tables 8 to 10.

In the following Table 11 the previous tables 8 to 10 (group 2) are further re-grouped to show the total children observed in each age-group irrespective of the relationship of the adult case :—

Children Exposed to Risk.											Control.		
Total Number Observed.			D. = Actual Number of Deaths. D-r. = Death-rate per 1,000. P.e. = Probable Error. M.v. = Maximum variation (= twice P.e.)								Lancashire—Geographical County—Death-Rate per 1,000 of Population Average 1921–1926.		
			Pulm. Tub.		Non-Pulm. Tub.		Other Causes.		All Causes.				
M	F		M	F	M	F	M	F	M	F		M	F
(i) Age-Group 0—1 Years.													
194	234	D.	—	1	2	—	8	13	10	14	Pulm. Tub.	0·2	0·2
		D-r.	—	4·3	10·3	—	41·2	55·5	51·5	59·8	Non-Pulm. Tub.	1·9	1·3
428		P.e.	—	2·9	4·9	—	9·6	10·1	10·7	10·5	Other Causes	118·3	88·0
											All Causes	120·4	89·5
			M & F		M & F		M & F		M & F			M & F	
		D.	1		2		21		24				
		D-r.	2·3		4·7		49·1		56·1		D-r. All Causes	105·0	
		M.v.	*3·1*		*4·4*		*14·0*		*15·0*				
(ii) Age-Group 1—2 Years.													
169	199	D.	—	—	2	1	2	6	4	7	Pulm. Tub.	0·5	0·3
		D-r.	—	—	11·8	5·0	11·8	30·1	23·7	35·2	Non-Pulm. Tub.	2·2	1·6
368		P.e.	—	—	5·6	3·4	5·6	8·2	7·9	8·8	Other Causes	33·4	30·4
											All Causes	36·1	32·3
			M & F		M & F		M & F		M & F			M & F	
		D.	—		3		8		11				
		D-r.	—		8·1		21·7		29·9		D-r. All Causes	34·2	
		M.v.	—		*6·3*		*10·2*		*11·9*				
(iii) Age-Group 2—5 Years.													
98	113	D.	—	—	1	1	3	1	4	2	Pulm. Tub.	0·2	0·1
		D-r.	—	—	10·2	8·8	30·6	8·8	40·8	17·7	Non-Pulm. Tub.	0·9	0·8
211		P.e.	—	—	6·8	6·0	11·7	6·0	13·5	8·4	Other Causes	8·0	7·4
											All Causes	9·1	8·3
			M & F		M & F		M & F		M & F			M & F	
		D.	—		2		4		6				
		D-r.	—		9·5		18·9		28·4		D-r. All Causes	8·7	
		M.v.	—		*8·9*		*12·6*		*15·4*				

Group 2. TABLE 12.

Analysis of Causes of Death.

The following table shows the causes of death among the children born in the same household as tuberculous parents and other relatives suffering from pulmonary tuberculosis with negative or no sputum, and contrasts the proportion of deaths from particular causes with the corresponding figures for England and Wales :—

Cause of Death.	Children Exposed to Risk.										Control : England and Wales.† Percentage to Total Deaths Ages 0—5. (Average for 6 years 1921–26).
	Age and Sex of Children who died from the subjoined diseases.									Percentage to Total Deaths Ages 0—5.	
	0—1		1—2		2—5		Total, 0–5.				
	M	F	M	F	M	F	M	F	M&F		
Tuberculosis of the Respiratory System ...	—	1	—	—	—	—	—	1	**1**	**2·4**	**0·6**
Other Forms of Tuberculosis :											
(a) Bones and Joints ...	—	—	—	—	—	—	—	—	—		
(b) Abdomen	—	—	1	1	—	—	1	1	**2**		
(c) Tub. Meningitis ...	1	—	—	—	1	—	2	—	**2**	**17·1**	**3·8**
(d) General Tuberculosis ...	1	—	—	—	—	1	1	1	**2**		
(e) Peripheral Glands ...	—	—	1	—	—	—	1	—	**1**		
Measles	—	—	—	—	—	—	—	—	—		
Scarlet Fever	—	—	—	—	—	—	—	—	—		
Whooping Cough	—	—	—	—	—	—	—	—	—	—	**13·1**
Diphtheria	—	—	—	—	—	—	—	—	—		
Influenza	—	—	—	—	—	—	—	—	—	—	**1·5**
Meningitis—Not Tuberculous	3	2	—	—	—	—	3	2	**5**	**12·2**	**1·6**
Bronchitis	—	2	—	—	—	—	—	2	**2**		
Pneumonia—All Forms ...	1	2	2	3	1	1	4	6	**10**	**29·3**	**25·7**
Other Respiratory Diseases ...	—	—	—	—	—	—	—	—	—		
Congenital Debility, congenital malformation, premature birth, etc.	1	—	—	1	—	—	1	1	**2**	**4·9**	**27·7**
Convulsions	2	3	—	1	2	—	4	4	**8**	**19·5**	**4·5**
Miscellaneous :											
Heart Disease	—	—	—	—	—	—	—	—	—		
Diarrhœa, &c.	1	—	—	—	—	—	1	—	**1**		
Encephalitis Lethargica ...	—	—	—	—	—	—	—	—	—		
Infantile Paralysis	—	—	—	—	—	—	—	—	—	**14·6**	**21·5**
Accident	—	—	—	—	—	—	—	—	—		
Cause not Known	—	4	—	1	—	—	—	5	**5**		
TOTAL DEATHS	10	14	4	7	4	2	18	23	**41**	**100·0%**	**100·0%**
Number of CHILDREN OBSERVED in each age-group	194	234	169	199	98	113	* 194	* 234	* **428**	—	—

* These are the total number of individual children observed between birth and 5 years of age (see page 8, third paragraph).

† The control relates to England and Wales because the figures for the Geographical County of Lancaster were not readily available.

Conclusions from Tables 8 to 12.

(*Group 2. Adult Negative Sputum Cases*).

1. There was one death from *pulmonary tuberculosis* among the children exposed to risk, and no conclusion can properly be based on this experience.

2. The separate figures for children of tuberculous mothers, fathers, and other relatives, given in tables 8, 9 and 10 respectively, are too small upon which to base conclusions, and it is necessary to examine the totals of the three tables in question, given in the summary table 11.

3. The death-rate from *non-pulmonary tuberculosis* of children exposed to risk is greater than that of the " control " children in the Geographical County of Lancaster, in age groups 0—1, 1—2 and 2—5, but after allowing for twice the probable error, the differences are not significant. It may be noted that this excess of the non-pulmonary death-rate, although statistically not sound upon which to make a definite conclusion owing to the factor of chance, follows the trend of the children in households with an adult positive sputum infective case.

4. The death-rate from *causes other than tuberculosis* was (*a*) among 428 children in age group 0—1 half of the " control " rate, (*b*) among 368 children in age group 1—2, two-thirds of the " control " rate ; but (*c*) the position was reversed among 211 children in age group 2—5, the rate being twice as much as the " controls " (although this difference can be discounted by the operation of the " probable error "). The experience for all three age groups supports the conclusions for the positive sputum infective cases.

5. The death-rate from *all causes* among the children exposed to risk (*a*) in age group 0—1 was lower than the " control " population —56·1 against 105·0—a significant difference ; (*b*) in age group 1—2 again lower but not significant ; but (*c*) in age group 2—5 the reverse is recorded, the rate among the children exposed to risk being three times as great as the " control "—a significant difference.

Mortality during First Five Years of Life.

(*Groups* 1 *and* 2).

In the preceding tables 1 to 5 and 8 to 11, the death-rates of the children exposed to risk have been dealt with in three age groups. It will be of interest to see how the total death-rate among children in tuberculous households who have had an opportunity of living five years compares with the death-rate of children of the same age in the Geographical County. The following table makes this comparison :—

TABLE 13.

Type of Adult Infective Case in Household.	No. of Children exposed to risk and observed for five years. Born in 1919, 1920, and 1921.	Death-rate per 1,000 from *All Causes*.	Maximum Variation (= twice the prob. error).	CONTROL. No. of deaths from *All Causes* expected to occur in a group of 1,000 children during first five years of life.*
Pulmonary Tuberculosis :				
Positive Sputum ...	329	112·46	23·50	119·31
Negative Sputum ...	114	114·03	40·14	

* Registrar-General's Decennial Supplement, England and Wales, 1921, Part I, Life Tables, L. T. No. 9 (male and female averaged). N.B.—Separate figures for Lancashire not available.

The *conclusion*, therefore, may be drawn that the children in tuberculous households do not suffer, in the first five years of life, a death-rate from all causes significantly different from the normal.

Group 3.—Children in tuberculous households in which the adult case suffered from NON-PULMONARY TUBERCULOSIS.

There were forms sent in by tuberculosis officers for only 35 children in households where their exposure to risk was in regard to an adult relative (there was no case of an adult lodger) suffering from non-pulmonary tuberculosis. The numbers are too small upon which to make any conclusion or detailed classification, and the following table will be sufficient record :—

TABLE 14.

Position at Age :		Relationship of Adult Case to Children Exposed to Risk.			Total.	Remarks.
		Mother.	Father.	Other Relative.		
0—1	Living	7	18	8	33	Both died from other than tuberculosis.
	Died	—	1	1	2	
1—2	Living	3	14	6	23	Both died from other than tuberculosis.
	Died	—	1	1	2	
2—3	Living	3	11	5	19	Died from other than tuberculosis.
	Died	—	1	—	1	
3—4	Living	2	6	5	13	
	Died	—	—	—	—	...
4—5	Living	—	4	4	8	
	Died	—	—	—	—	...

V. COMPARISON OF RESULTS WITH CERTAIN OTHER PUBLISHED RESEARCH.

In this chapter is given a summary of the more important *papers* on this subject, and after each are added comparative figures from the present Lancashire research :—

(1) Dr. Percy Stocks (*Annals of Eugenics*, Vol. III, parts I and II, April, 1928, p. 95) states, that the examination of the family records of approximately 4,000 patients who attended the Belfast Tuberculosis Institutions in 1914–17, indicates " that the children of tuberculous parents were subject to higher rates than the general population. The excessive rate in children was much more pronounced when both parents were tuberculous than when only one was affected, and more pronounced when the mother was affected than when the father was affected."

The *Lancashire* research supports the conclusion as to the children of tuberculous mothers being more frequently affected than when the father is affected. There are insufficient figures for children with both parents tuberculous to confirm or disprove the Belfast experience for this group.

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(2) Professor Major Greenwood (in the *British Medical Journal* for 12th May, 1928), makes reference to several investigators abroad who have published interesting figures, which (without reference to the original text) are re-quoted below :—

Weinberg (Germany), Kjer-Petersen and Ostenfeld (Denmark), Bergman and Dörner, in their several investigations, made the rate of mortality from tuberculosis of children of tuberculous parents or of children exposed to massive infection, in the first year of life, to be between 5 and 10 per cent.

The Lancashire investigation shows the tuberculosis mortality of age-group 0—1 to be :—

(*a*) Children of tuberculous positive sputum mothers—3·2 per cent. died from tuberculosis (all forms).

(*b*) Children of tuberculous positive sputum fathers—1·3 per cent. died from tuberculosis (all forms).

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(3) In the United States, Dr. M. A. Asserton, in "A Study of Tuberculosis in Infants" (*Tubercle*, April, 1928), gives statistics obtained by the Children's Service of the New York Tuberculosis and Health Association concerning infants under 2 years of age who had attended two of the hospitals for some form of treatment. Of *149 infants* exposed to infection by the existence of one or more cases of tuberculosis in the immediate family, or among lodgers, visiting friends or near neighbours, *56 per cent.* were dead when followed up. The number of years after is not stated, but it would appear to be at least up to eight years. In another group of 187 infants not exposed to tuberculosis, 35 per cent. died. The children observed, however, were those who had attended two New York Hospitals for treatment of various diseases and ailments common to them.

The Lancashire research cannot be put in comparison, because the children observed in New York had attended hospitals for treatment and were not, therefore, typical of the general infant population.

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(4) A Danish physician, Dr. H. Heckscher (as reported in the *British Medical Journal* of 6th October, 1928, p. 620) has investigated the fate of 204 living infants born of 75 tuberculous mothers (with active pulmonary disease) in the maternity department of a hospital in Copenhagen since 1918. Eleven of the children died from tuberculosis (= 5·4%), and 38 died from other diseases (= 18·6%), a total mortality from all causes of 24·0%.

The Lancashire investigation shows the tuberculosis mortality (all forms) among children of tuberculous (positive sputum) mothers to be 3·2 per cent., and for other diseases 8·2 per cent. ; total 11·4 per cent.

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(5) Dr. W. H. Dickinson (in the *Newcastle-upon-Tyne and Northern Counties Medical Journal*, October, 1925), states : "Before the discovery of the tubercle bacillus, heredity was believed to be the decisive factor ; after 1882 infection with the specific bacillus came to be regarded as the most important cause, but in recent years the whole trend of medical opinion is to attach much more importance to environment, using the term in its widest application, than anything else.

" Not only is there a tendency to discount the importance of heredity as a predisposing factor, but some writers maintain that children of phthisical parentage inherit a definite resistance of tuberculosis."

Dr. Dickinson gives figures, in his own experience, of the deaths of children in the first year of life among those born of tuberculous mothers and fathers (sputum positive) which are set out briefly below :—

Relationship to Children exposed to risk.	No. of Children (excluding untraced).	No. Died from all causes during first year of life.	Death-rate per 1,000.
Tuberculous mother...	... 49	11	224·5
Tuberculous father ...	... 119	14	117·6

Dr. Dickinson states that these figures are too small from which to draw any definite conclusions.

Assuming the mothers and fathers had positive sputum sometime in life, the death-rates of the children in the first year of life are (i) almost twice as great as the Lancashire figure for the children of tuberculous mothers—i.e. 224·5 against Lancashire's 114·7, and (ii) nearly $1\frac{1}{2}$ times as great for the children of tuberculous fathers—i.e. 117·6 against Lancashire's 79·9.

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(6) Professor S. Lyle Cummins, Director of Research, Welsh National Memorial Association, states (in the sixteenth annual report of the Association) that not more than 4·5 per cent. of the children of tuberculous families observed by Dr. Howell Williams in Carmarthenshire had died from tuberculosis within the first five years of life.

In the Lancashire research, there were among the tuberculous (positive sputum) households 329 children who were observed during the first five years of life and 9 died from pulmonary or non-pulmonary tuberculosis, equal to 2·7 per cent. In the children of tuberculous (sputum negative or absent) households the mortality from tuberculosis was 1·8 per cent.

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(7) (*a*) Dr. P. C. Varrier-Jones, in his Mitchell Lecture (1927), stated that there had been in the Papworth Tuberculosis Colony " A complete absence during eleven years of clinical tuberculosis in the 133 children of men and women who are definite cases of the disease and in most instances show tubercle bacilli in the sputum from time to time."

(*b*) Dr. Varrier-Jones states (in a letter dated 20/12/28 to Dr. G. Lissant Cox), that the infant mortality among the children born at Papworth was 27·2 per 1,000 births (37 births, 1 death).

The general statement is important, as it shows that under hygienic conditions and medical supervision the children of tuberculous fathers (presumably the married settlers are nearly all men) do not contract tuberculosis.

The Papworth infant mortality of 27·2 is nearly one-third of the ordinary infant mortality for England and Wales.

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(8) Dr. A. Calmette, of Paris (who has experimented with the vaccine B.C.G. for the protection of children born of tuberculous mothers, or born in a tuberculous environment) quotes in his book *L'Infection Bacillaire et la Tuberculose chez l'homme et chez les animaux*, published in 1928, commencing on page 835, a number of investigations made into the mortality of children of tuberculous mothers, from which the following is extracted :—

> " It can be affirmed that actually in France more than 24 per cent. of the children born of tuberculous mothers or reared in an infected household, succumb to tuberculous infection in the first year of their existence."*†

It is not stated whether all the infective cases or how many of them were those of pulmonary tuberculosis with positive sputum.

The Lancashire research shows that the deaths from tuberculosis (all forms) of children of tuberculous (positive sputum) mothers in the age-group 0—1 year, equalled 3·2 per cent., and in age-group 1—2, 1·6 per cent. Presumably all Dr. Calmette's living cases were observed up to attaining one year of age (as distinct from falling in the group 0—1). All the 1,023 children in the Lancashire research were observed for full twelve months except 49 who might have been observed for a less time. However, even if the Lancashire figures for 0—1 and 1—2 are taken together, the percentage is under 5·0.

* It is important to note that Dr. Calmette's figures have been criticised by Professor Major Greenwood as being deduced from inadequate data. (*British Medical Journal*, May 12th, 1928.)

† In the *Bulletin de l'Union Internationale contre la Tuberculose* for January, 1928 (page 8), it is stated that the 24 per cent. of children " had died *presumably* of tuberculosis before the end of the twelfth month." The new word introduced, namely " presumably," I have put in italics.

It may be that the French tuberculosis mortality rate of 24 per cent. quoted by Professor Calmette relates to children reared under bad housing conditions. To compare with this, in the Lancashire research, the children from homes classified by the health visitors as "bad" have been dealt with separately for age-group 0—1; even so, the death-rate from Tuberculosis (all forms) is 1·7 per cent. (see page 18.)

Thus, the Lancashire results do not agree at all with the figure mentioned by Dr. Calmette.

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(9) The Union Internationale contre la Tuberculose has very kindly supplied (February, 1929) the following information issued by the office National d' Hygiène Sociale. (As B.C.G. is mentioned, it may be explained that this is a vaccine prepared by Prof. A. Calmette, and is given by him to children born of tuberculous mothers or born in a tuberculous environment):—

"PREVENTIVE VACCINATION AGAINST TUBERCULOSIS BY MEANS OF THE B.C.G.

ENQUIRY OF JULY-AUGUST, 1928.

A comparison between the tuberculosis mortality and the general mortality of non-vaccinated and vaccinated children respectively, according to figures collected in 204 tuberculosis dispensaries in 1925, 1926 and 1927, throughout France.

Non-vaccinated children.		*Vaccinated children.*	
A.—Born of tuberculous mothers, not separated	1,989	A.—Born of tuberculous mothers, not separated ...	879
Tuberculosis mortality from 1 month to 4 years...	18%	Tuberculosis mortality from 1 month to 4 years...	3·6%
General mortality from 1 month to 4 years ...	24·2%	General mortality from 1 month to 4 years ...	16%
B.—Born and brought up in a tuberculous environment (excepting children born of tuberculous mothers).	2,865	B.—Born and brought up in a tuberculous environment (excepting children born of tuberculous mothers).	1,489
Tuberculosis mortality from 1 month to 4 years...	13·9%	Tuberculosis mortality from 1 month to 4 years...	2·6%
General mortality from 1 month to 4 years ...	18%	General mortality from 1 month to 4 years ...	8·9%
A & B together—		A & B together—	
Tuberculosis death-rate ...	15·9%	Tuberculosis death-rate ...	3·1%
General death-rate ...	21·1%	General death-rate ...	12·4%"

When comparing these figures with the Lancashire research, the following points emerge. It is not stated whether all the adult infective cases or how many of them were of pulmonary tuberculosis with positive sputum. The age-group 1 month to 4 years includes children observed from 30 days onwards to the completion of the fourth year (i.e. 3 years and 365 days), but, of course, excludes the deaths occuring in the first 30 days of life.

An attempt has been made, however, to compare the figures quoted above with the Lancashire results, although this is difficult owing to our age-group 0—4 years not corresponding exactly with the French age-group 1 month to 4 years :—

	France : Children not vaccinated by B.C.G. 1 month to 4 years.	France : Children vaccinated by B.C.G. 1 month to 4 years.	Lancashire : (none vaccinated by B.C.G.) Children observed for 4 years. Adult infective case : With sputum positive.	With sputum negative.	With sputum positive or negative.
	%	%	%	%	%
Children born in a tuberculous environment (including children of tuberculous mothers) :					
Tuberculosis death-rate	15·9	3·1	2·73	0·87	2·26
All causes death-rate	21·1	12·4	10·64	11·52	10·61
Number of children observed ...	(4,854)	(2,368)	(329)	(114)	(443)

Here again, as in (8) *on pages* 33 *and* 34, *the Lancashire results, so far as they can be compared, do not agree with the French figures for children unvaccinated with " B.C.G."*

Further, our Lancashire investigation shows for children observed from birth to 4 *years of age, a death-rate lower than the French figure for children observed from* 1 *month to* 4 *years vaccinated with " B.C.G."*

In making comparisons between results obtained in Lancashire and in France, it must not be forgotten that there is a factor which probably varies greatly in the two countries. This is the amount of

supervision by skilled tuberculosis health visitors in the homes of persons suffering from tuberculosis, and also the amount of institutional accommodation available for and used by the population of the two countries.

Lastly, it is interesting to note that, according to " l'Union Internationale contre la Tuberculose," the infant mortality per 1,000 births in 1927 in the Department of the Seine was 83·3, whereas in the Geographical County of Lancaster it was 73 ; for the whole of France the figure in 1927 was also 83·3, whereas in England and Wales it was 70.

VI. SUMMARY AND CONCLUSIONS.

1. The research embraces the analysis of the histories of 1,486 children in Lancashire under five years of age living in 1,063 homes, in each of which there were one or more adults suffering from tuberculosis. There has been no selection of cases by tuberculosis officers, and no undue proportion from any particular area or areas.

2. Of the children dealt with in this research, the substantial majority remained, throughout their period of observation, in constant contact with an adult tuberculous case in their homes, after allowing for those adults who received several months institutional treatment and for a small number of children who were removed for varying short periods to the homes of relatives.

3. The death-rate from *Non-Pulmonary Tuberculosis* of children exposed to risk in tuberculous households from an adult with *positive sputum* (see table 5) was greatly in excess of the rate from the same cause in the Geographical County of Lancaster, serving as the " control "—the rate being :—

Nine times greater in the age-group 0—1 ;
Fourteen times greater in the age-group 1—2 ;
Nineteen times greater in the age-group 2—5.

This great excess of Non-Pulmonary Tuberculosis is mainly due to deaths from Tuberculous Meningitis, which accounted for two-thirds the mortality in the non-pulmonary group, ages 0–5. (See page 17).

4. Similarly (although statistically insignificant owing to the probable error due to chance), the death-rate from *Non-Pulmonary Tuberculosis* of children exposed to risk in tuberculous households (see table 11 on page 25) with an adult case or cases suffering from pulmonary tuberculosis, with *negative or no sputum*, was also in excess of the rate from the same cause among children in the geographical County of Lancaster, the rate being :—

Three times greater in the age group 0—1 ;
Four times greater in the age-group 1—2 ,
Ten times greater in the age-group 2—5.

5. The deaths from *Pulmonary Tuberculosis* of children exposed to risk in tuberculous households were too small upon which to base any conclusion.

6. The death-rate from *causes other than tuberculosis*, on the other hand, was appreciably less among the children aged 0—1 and 1—2 exposed to risk from an adult with pulmonary tuberculosis than in the corresponding child population in Lancashire. From 2—5 years, however, the position was reversed.

7. With regard to the deaths from *all causes* :—

(*a*) We have found that in the first year of life the children in tuberculous households had a death-rate significantly below the corresponding rate in Lancashire, 15 per cent. less when the infective case had a positive sputum, and 46 per cent. less when the sputum was negative or absent. This lower mortality of the children exposed to risk appears remarkable, but it must not be overlooked that the tuberculous household is under the supervision of the medical and nursing staffs, who are able to give advice as to the feeding and health of the children as well as to obtain assistance for necessitous cases. In connection with this lower mortality from all causes in children under one year, Dr. C. W. Laird draws attention to the work of Professor Abderhalden of Halle who claims to have discovered proteolytic ferments in the blood of pregnant women which were not to be found apart from pregnancy.

(*b*) Between 1—2 years, the death-rate was almost the same as the corresponding rate for Lancashire ;

(*c*) In age group 2—5 years, the death-rate was significantly higher—due in part to the much greater mortality from tuberculosis—among the children in tuberculous households than in the " control," being five times greater when the infective case had a positive sputum, and three times greater when negative or absent.

8. The mortality rate from tuberculosis was greater amongst the children of tuberculous positive sputum mothers than fathers.

9. Taking a period covering the whole first five years of life, those children who were in contact at home with an adult person suffering from pulmonary tuberculosis (whether sputum positive or negative), did not have a higher mortality from all causes when compared with the expectation of life of children in England and Wales. (See page 28).

10. The calculation made by Professor A. Calmette, that in France 24 per cent. of the children of tuberculous mothers die from tuberculosis in the first year of life if left with the mother is many times higher than our Lancashire experience. This research shows that the death-rate from tuberculosis for corresponding Lancashire children was 3·2 per cent. ; and further, from all causes the rate was only 11·5 per cent. (See pages 33 and 34).

11. Further, the Lancashire investigation shows for children observed from birth to 4 years of age a death-rate, from tuberculosis, and from all causes, a little lower than the French figure for children observed from one month to 4 years vaccinated with "B.C.G."; and much lower than for the French children unvaccinated with "B.C.G." (See pages 34 and 35).

Many workers have assisted in this lengthy and laborious research, and acknowledgments are due, first, to the tuberculosis officers and the nurses working under them for the collection of the raw material; second, the presentation of this report would have been quite impossible without the invaluable assistance given me by my chief clerk, Mr. H. F. Hughes, and other members of the tuberculosis department. Lastly, I am indebted to Professor Major Greenwood for some valuable suggestions, and have to thank Dr. C. O. Stallybrass, of Liverpool, for very kind assistance in the mathematical problems inherent in this research.

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Convener.

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18*th March*, 1929.